Green Infrastructure Planning for Performance

Troy R. Naperala, PE

Introduction

- What is Green Infrastructure?
- What are the Goals of Green Infrastructure?
  - Water Quality Issues
- Planning Considerations
  - Watershed, neighborhood, site
- Examples
- Lessons Learned

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What is Green Infrastructure?

"Green infrastructure uses vegetation, soils, and natural processes to manage water and create healthier urban environments. At the scale of a city or county, green infrastructure refers to the patchwork of natural areas that provides habitat, flood protection, cleaner air, and cleaner water. At the scale of a neighborhood or site, green infrastructure refers to stormwater management systems that mimic nature by soaking up and storing water."

http://water.epa.gov/infrastructure/greeninfrastructure/gi_what.cfm

<u>Examples</u>

- Downspout Disconnection
- Rainwater Harvesting
- Rain Gardens
- Planter Boxes
- Bioswales
- Permeable Pavers
- Green Alleys and Streets
- Green Parking
- Green Roofs
- Urban Tree Canopy
- Land Conservation

<u>Benefits</u>

- Surface water quality/ quantity
- Groundwater Recharge
- Habitat
- Air Quality
- Energy and Climate

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What are the Goals of Green Infrastructure?

- Manage Small Frequent Storms
  - Water Quality
  - Water Quantity

  } Not Traditional Stormwater Management Goals.
  - Aesthetics, Carbon reduction, Energy Use, Air Quality
- Key differences from Traditional Stormwater Management
  - Diffuse locations
  - Water Quality
  - Volume Reduction
  - Habitat
  - More "Public" Than Traditional Infrastructure

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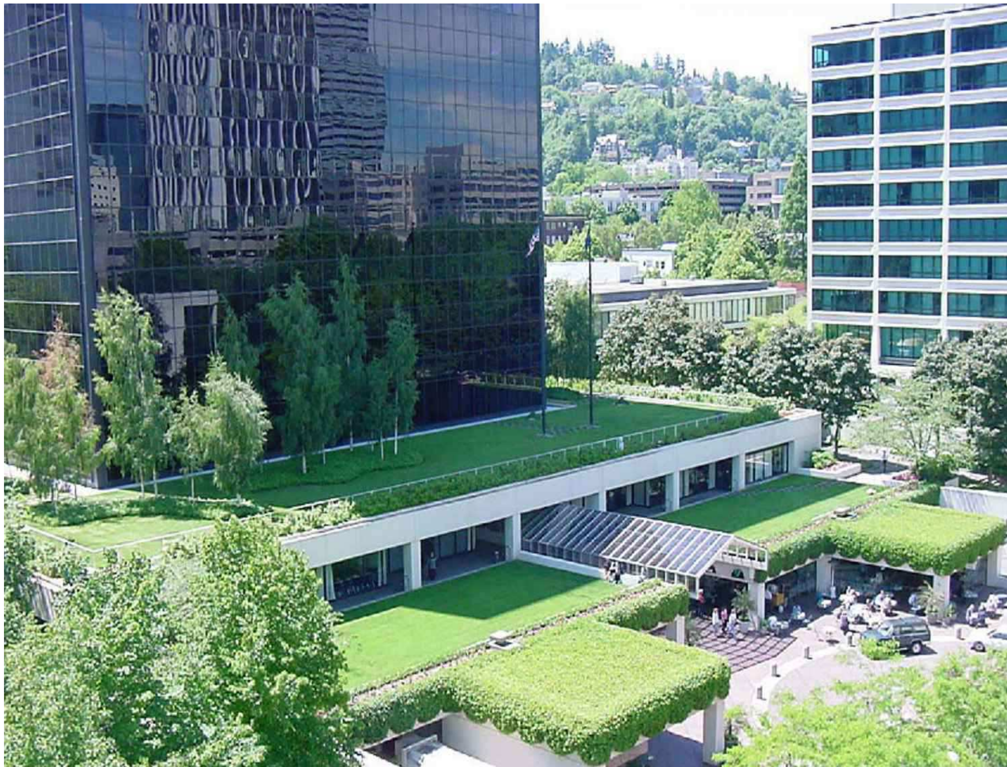
Green Roof Applications



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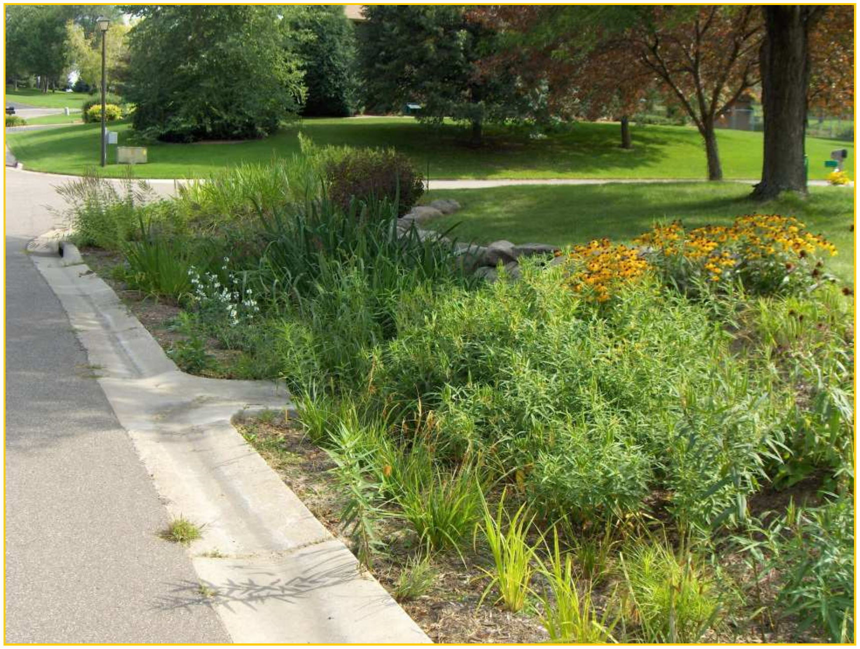
Pervious Infrastructure

Rain Gardens and Bioswales



Water Quality Issues Associated with Storm Water

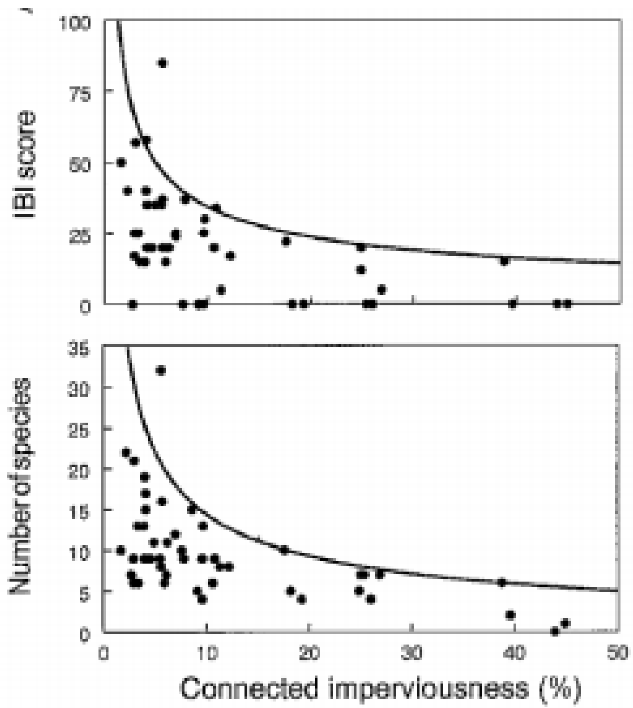
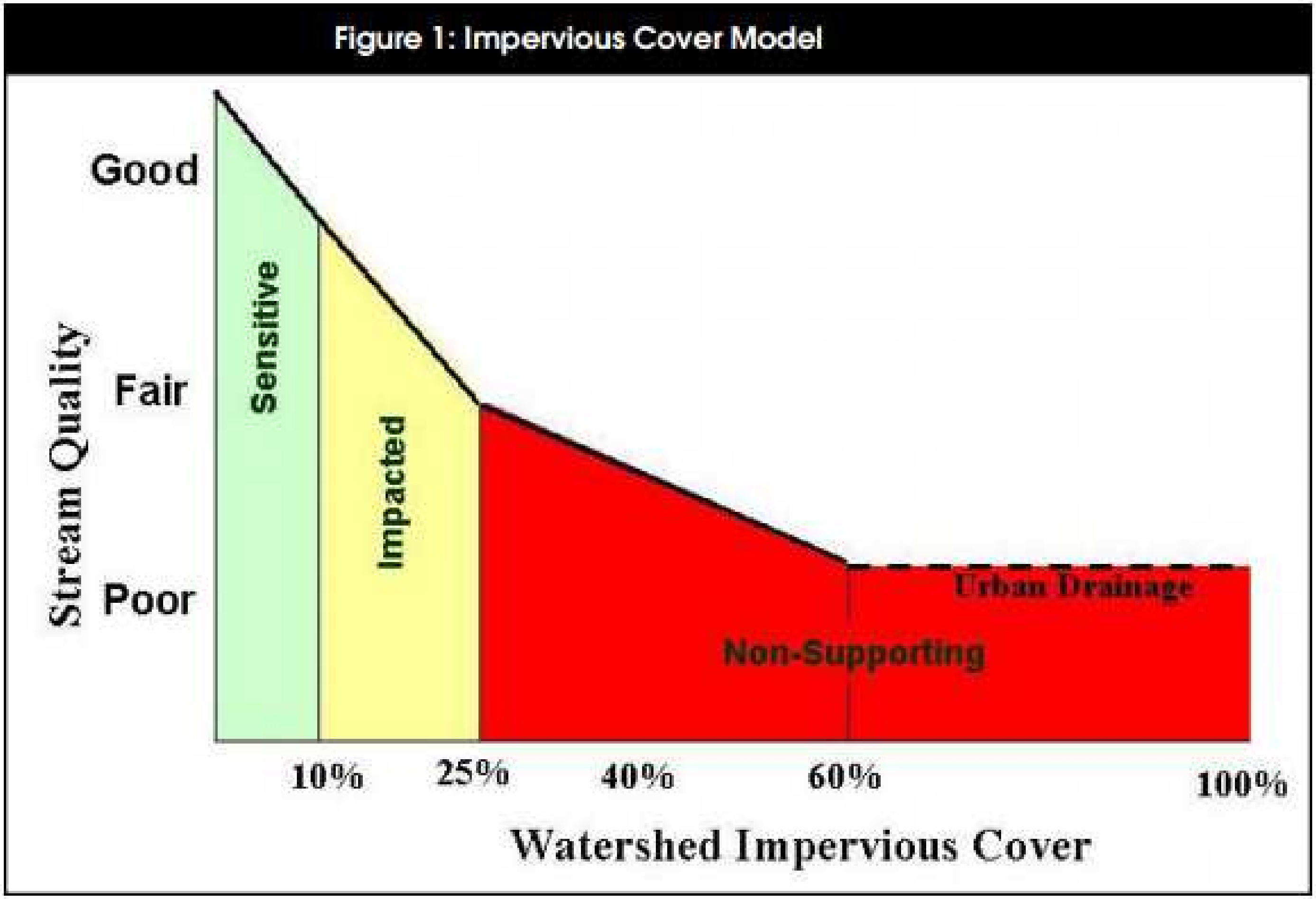


FIGURE 1-4 Plots of Effective Impervious Area (EIA, or "connected imperviousness") against metrics of biologic response in fish populations. SOURCE: Reprinted, with permission, from Wang et al. (2001). Copyright 2001 by Springer.

Water Quality Issues Associated with Storm Water



Source: Watershed Protection Research Monographs No. 1, Impacts of Impervious Cover on Aquatic systems. March 2003. Prepared by Center for Watershed Protection 8391 Main Street Ellicott City, MD 21043.

Water Quality Issues Associated with Storm Water

BOX 3-7 Continued

TABLE 3-2A Dissolved Nitrate and Total Nitrogen Export Rates from Forest and Developed Land-Use Catchments in the Baltimore Ecosystem Study

Catchment	Land Use	Nitrate (kg N/ha/yr)			Total N (kg N/ha/yr)		
		2000	2001	2002	2000	2001	2002
Pond Branch	Forest	0.11	0.08	0.04	.47	.37	0.17
McDonogh	Agriculture	17.6	12.9	4.3	20.5	14.5	4.5
Baisman Run	Mixed Forest and Suburban	7.2	3.8	1.5	8.2	4.2	1.7
Dead Run	Urban	3.0	2.9	2.9	5.6	5.3	4.2

TABLE 3-2B Dissolved Phosphate and Total Phosphorus Export Rates from Forest and Developed Land-Use Catchments in the Baltimore Ecosystem Study

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McDonogh	Agriculture	0.12	0.080	0.022	0.22	0.14	0.043
Baisman Run	Mixed Forest and Suburban	0.009	0.005	0.002	0.02	0.011	0.004
Dead Run	Urban	0.039	0.037	0.03	0.10	0.10	0.08

Source: Shields, C., L.E. Band, N. Law, P. Groffman, S. Kaushal, K. Savvas, G. Fisher, K. Belt. In Press. Streamflow distribution of nonpoint source nitrogen export from urban-rural catchments in the Chesapeake Bay Watershed. Water Resources Research.
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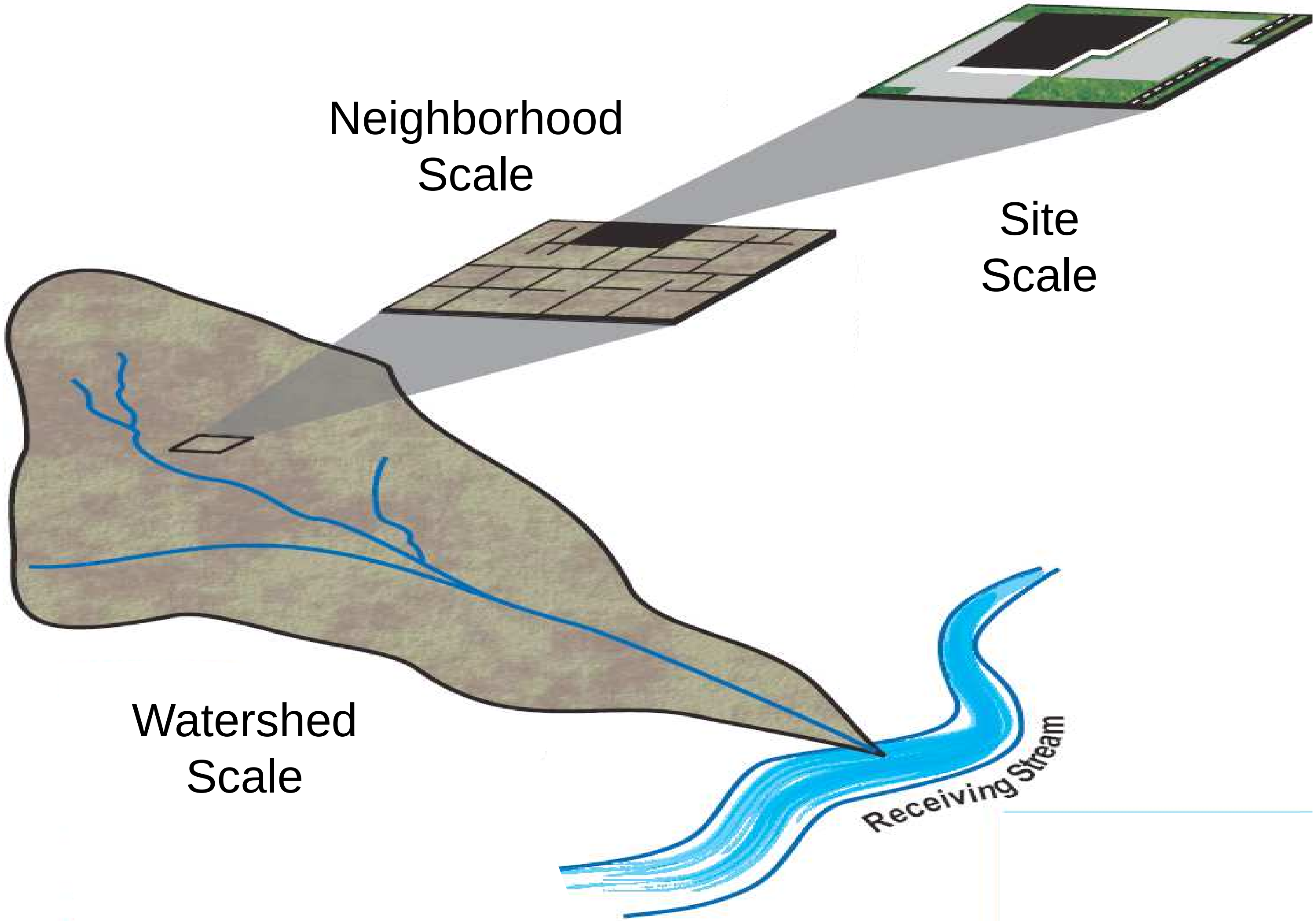
What do I mean by “Planning for performance”?

- There is a lot of literature about the benefits of individual types of GI…we can get percent removal efficiencies or typical outlet concentrations
- When retrofitting an area planning to meet a specific target with a specific budget can lead to optimization
- Planning allows projects to achieve water quality/ quantity goals for a larger area while optimizing cost and effectiveness
- Planning is important at each “scale”

Planning Considerations



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Planning Considerations

Watershed Scale	Neighborhood Scale	Site Scale

• Goals and Targets
• Regulatory Drivers
• Public Engagement
• Budget (Capital and O&M)
• Watershed Characterization
• Prioritize Locations
• Prioritize GI Types
• Alternatives
• Implementation Period
	• Verify Physical Suitability of Sites
	• Collect Data
	• Public Engagement
	• Budget (Capital and O&M)
	• Select Locations
	• Select GI Types
	• Develop Design and Construction Schedule
		• Collect Data
		  • Infiltration
		  • Utilities
		  • Contamination
		• Cost Estimating
		• Implement Design and Construction Schedule

Outputs: Develop plan to meet goals within budget and other constraints	Refine projects, project locations, and costs	Engineer, design, construct, and maintain

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Planning Considerations

Watershed Scale

- Source Assessment
- Potential Locations
- Feasible GI Types
- Costs

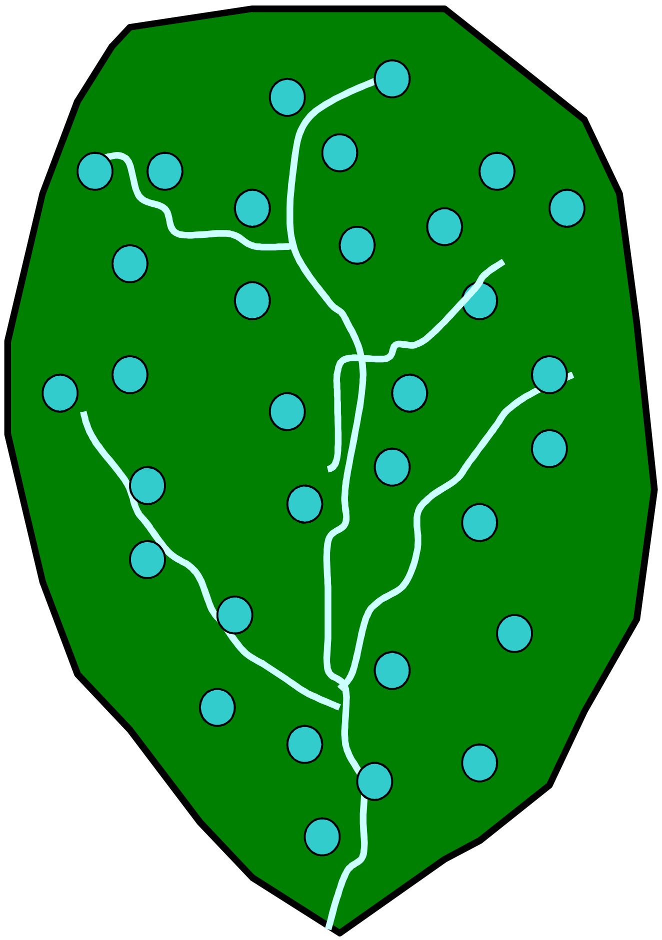
Neighborhood Scale

- Select Sites
- Collect Data
- Select GI Types
- Develop Design and Construction Schedule
- Public Engagement

Site Scale

- Collect Data
- Cost Estimating
- Design
- Construct
- Maintain

Planning Considerations



Distributed GI
Stormwater Features

<u>Prioritization/ Optimization Analysis</u>

- Treatment Effectiveness (quality and quantity)
- Public Acceptance
- Synergy with non-priority opportunities
- Capital Cost
- O&M Cost
- Greatest treatment for least cost

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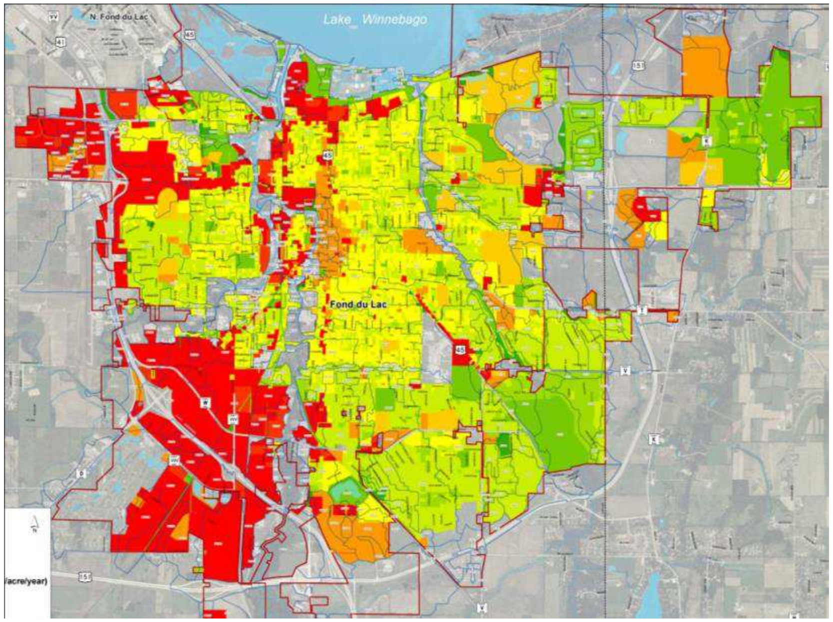
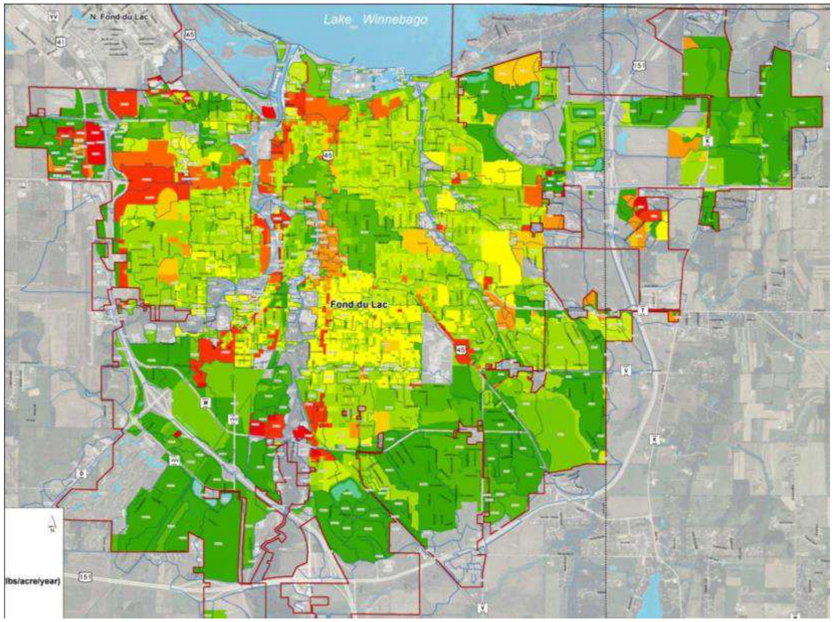
Watershed Scale Example



- Set target
- Analyze sources
- Identify locations and types
- Assess level of control
  - Do BMPs achieve target?



Key

- Red = more pollutants
- Green = less pollutants

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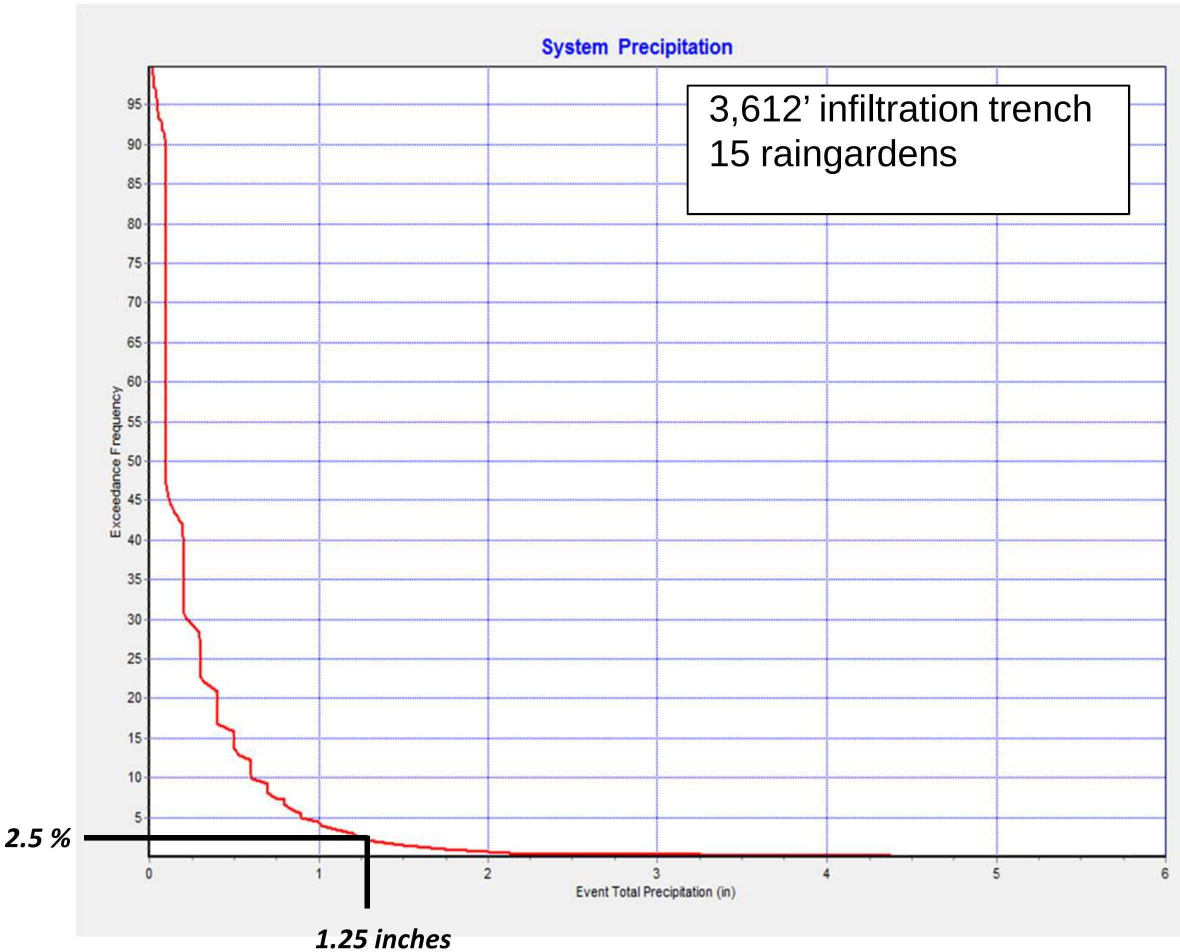
Watershed Scale Example

- Goal: To reduce bacteria loading from storm water outfalls to Village Beaches



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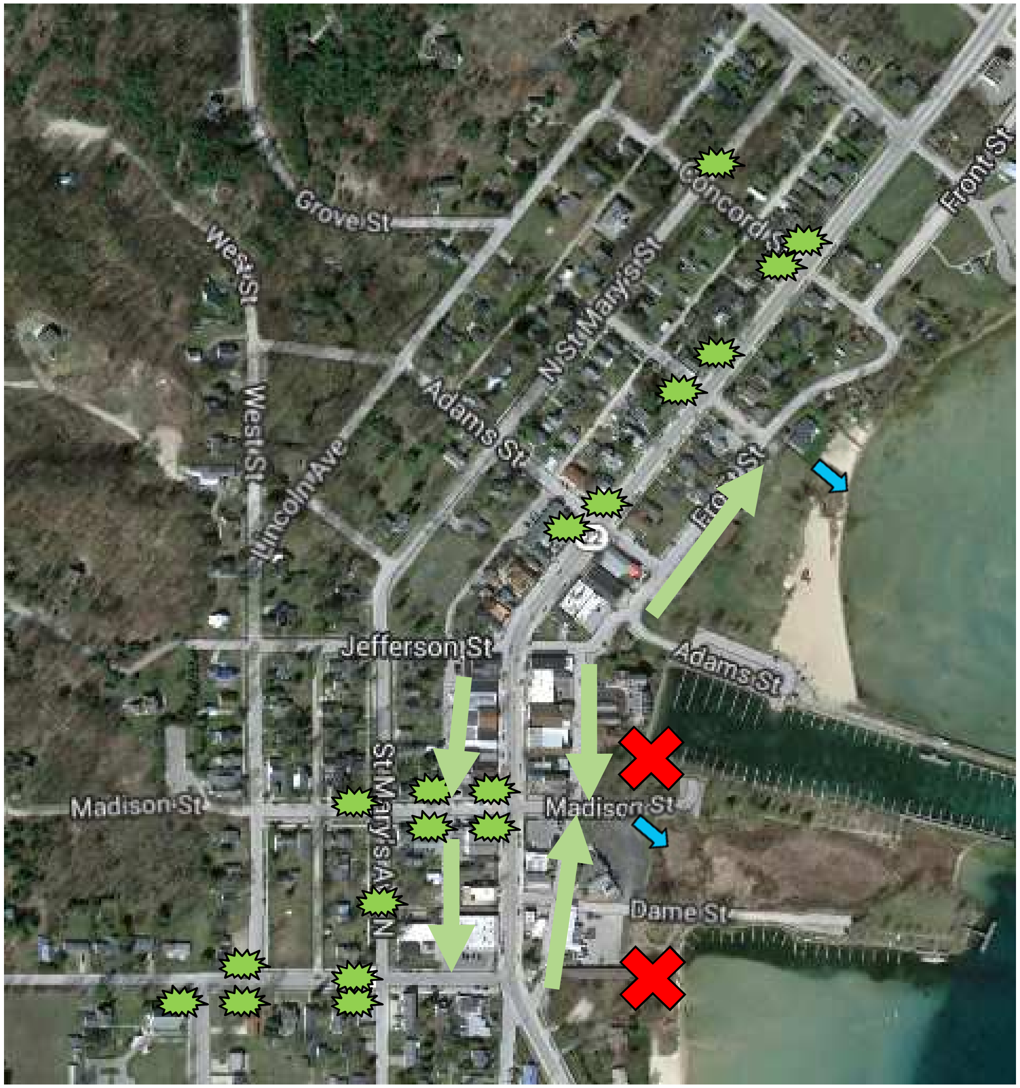
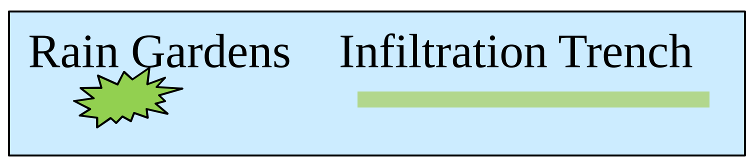
Watershed Scale Example



- Locations
- Size
- Treatment
- Volume
- Cost

Maximized Treatment for Available $



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Neighborhood Scale Example

BIORETENTION EXAMPLE

Sidewalk Planters - Linear detention or retention planters located linearly along a sidewalk in the furnishings zone.

- Required Footprint = 5% x DMA (for CSD)
- Required Footprint = 8% x DMA (for flooding)

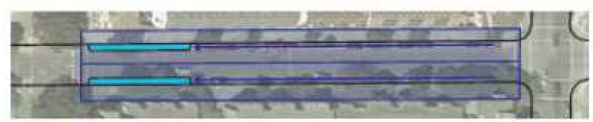
Bulbout Planters - Both detention and retention bioretention facilities located in curb extensions or bulbouts at the downstream end of the area managed.

Proposed Flow-Through Sidewalk Planter

DMA Plan

technology footprint
drainage management area
flow direction

Proposed Bioretention Bulbout



DMA Plan

technology footprint
drainage management area
flow direction

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Neighborhood and Site Scale Example

Burnsville, MN

Residential Neighborhood

Rain Garden Retrofits

Long-Term Monitoring

Photos Courtesy of Rice Creek Watershed District

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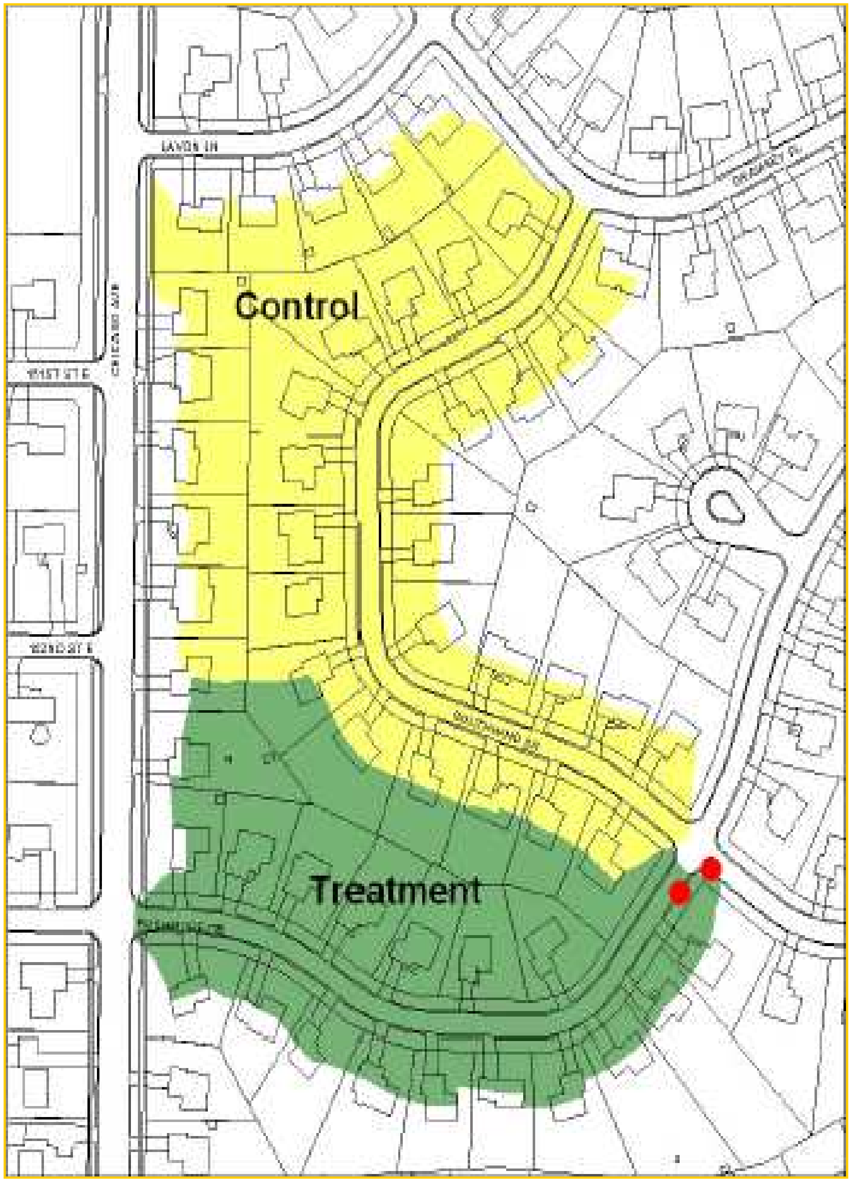
Neighborhood and Site Scale Example



Paired Study of Residential Street Runoff Control

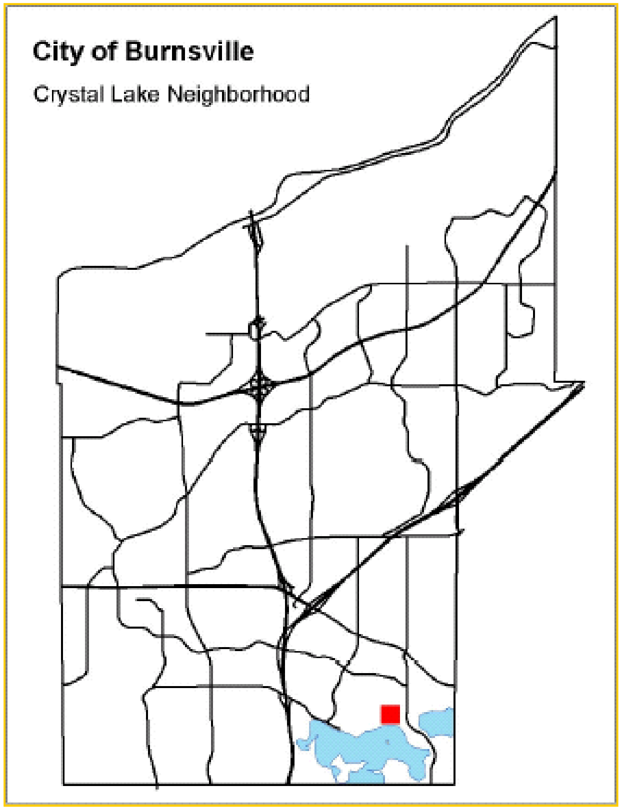


Diagram courtesy of the City of Burnsville, MN from their Burnsville Stormwater Retrofit Study

Neighborhood and Site Scale Example

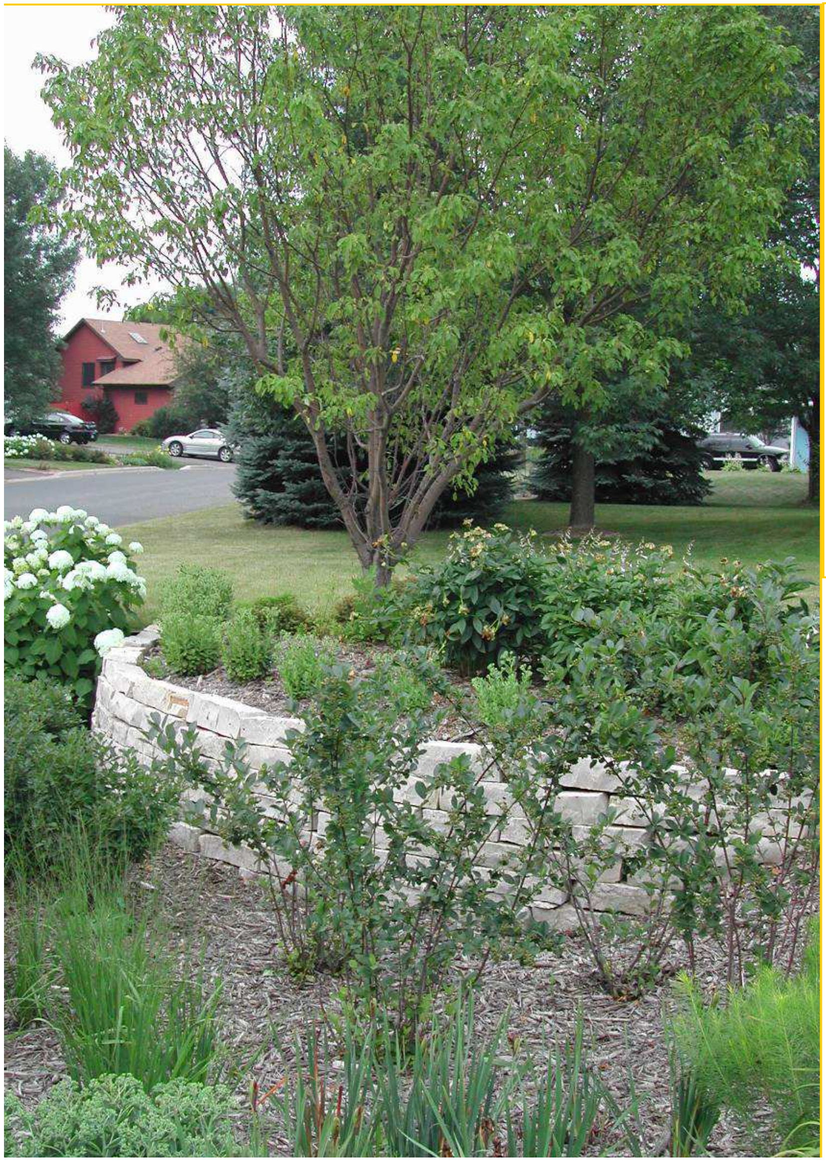


Diagram courtesy of the City of Burnsville, MN from their Burnsville Stormwater Retrofit Study

17 Rain Gardens

5.3 acres treated and 7.5 acres controlled

Average treated lot < .5 acres

Average total rain gardens < 1 acre

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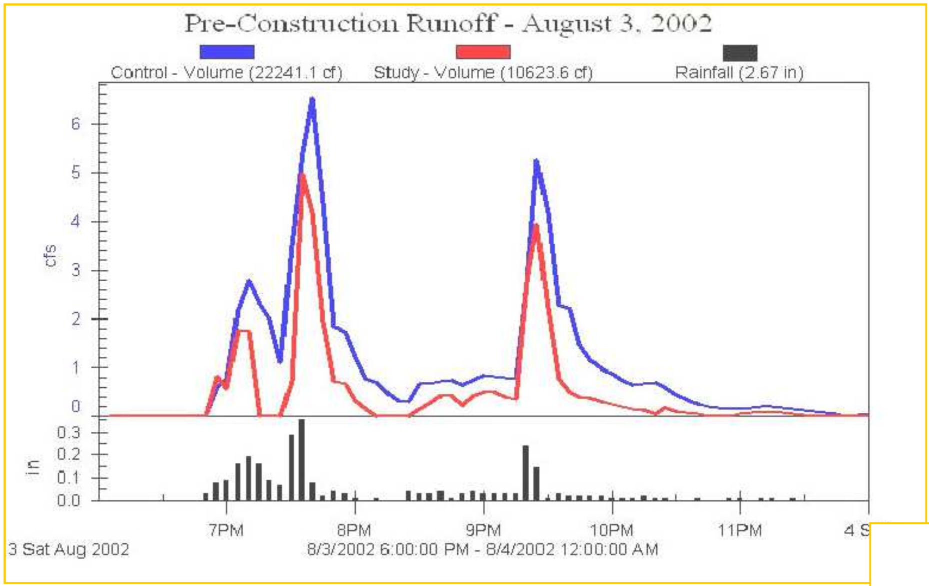
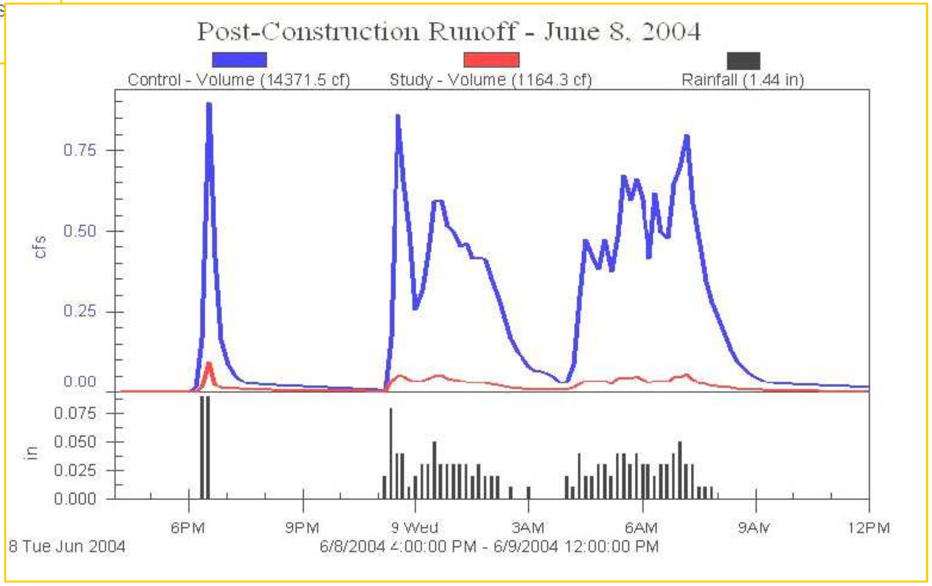
Neighborhood and Site Scale Example





Blue: Control

Red: With Rain Gardens

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Lessons Learned

- Cost estimating at watershed scale is challenging
- Setting targets helps drive performance
- Not all identified locations will work
- Site specific data is very important for site specific performance
- Long term costs
- Maintenance is required

Closing Thoughts

- Watershed scale planning allows for economic optimization of GI types and locations
- To achieve goals/ targets neighborhood analysis and site scale engineering and designs need to be consistent with early planning
- Constraints need to be well understood at beginning of project
- Public perception
- Opportunity to “marry” two forms of public work effort (street, sidewalks, stormwater management)

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Thank You

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June 4, 2015

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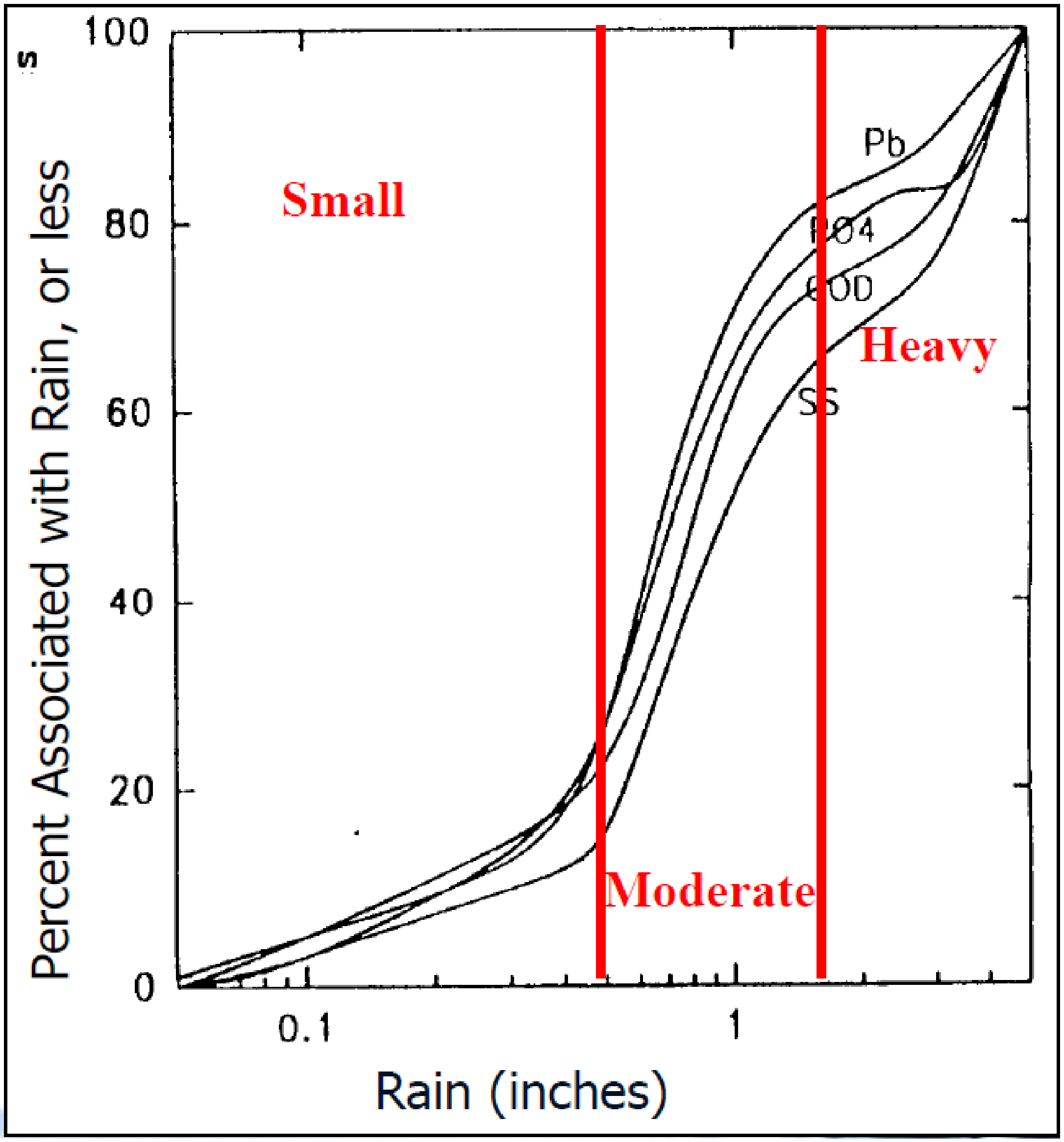

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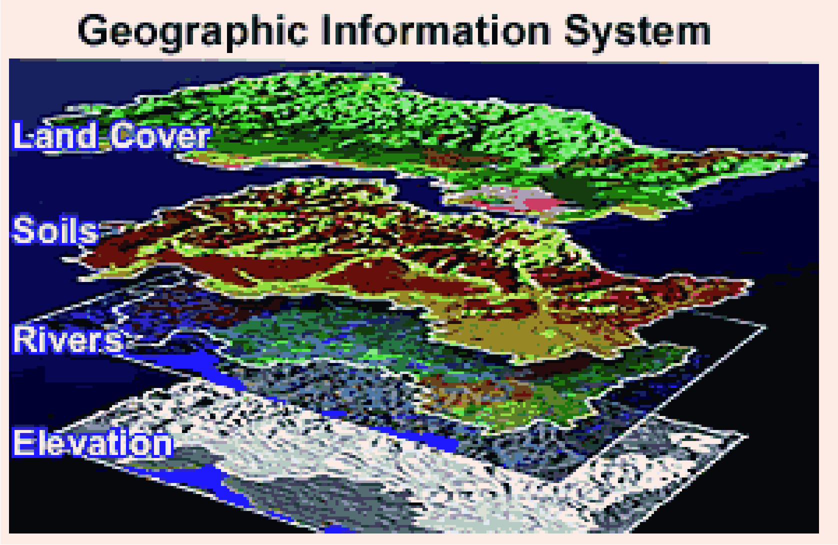
Watershed Scale Planning

- Discuss goals, constraints, and funding with owner
  - Storm size targeted for control
  - Pollutant of concern
  - Limitations on location
  - Construction budget
- GIS Data Analysis
  - Topography,
  - Hydrography
  - Soils
  - Land use



- Collect and analyze site specific data

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What is Our Approach to Green Infrastructure?

-**Designed** Holistically

-**Planned** Comprehensively

-Laid Out **Strategically**

-Planned and Implemented **Publically**

-Grounded in principles and practices of **Diverse Professions**